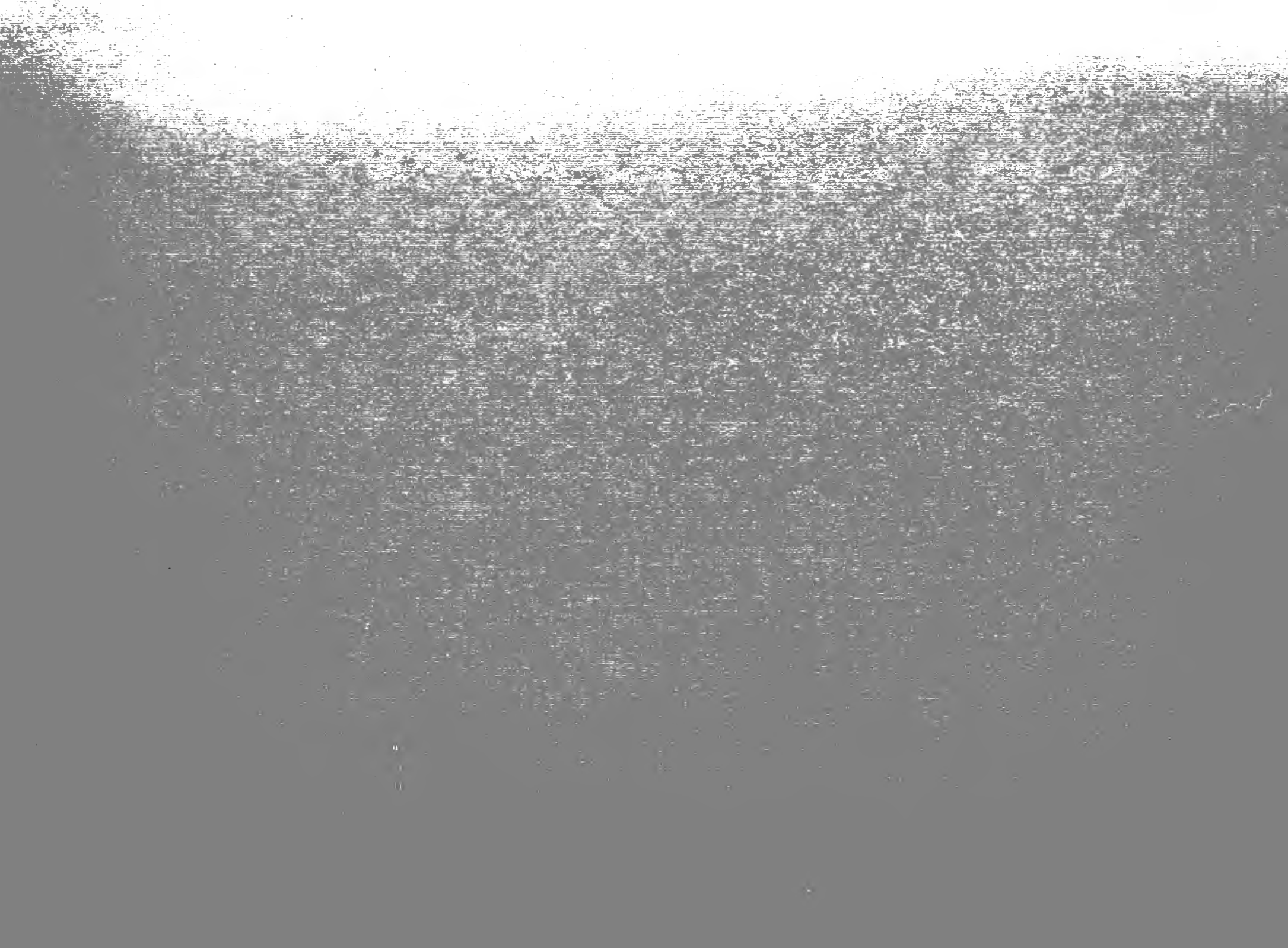

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FACULTY WORKING PAPER NO. 1188

The First Rational Bubbles: A New Look at the Mississippi and South Sea Schemes

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September 1985, Comments Invited.

The authors acknowledge with gratitude helpful comments and criticisms of earlier drafts by Professors P. G. M. Dickson, Robert Flood, Charles Kindleberger, and Eugene White as well as by participants in seminars at the Cliometrics Conference at Miami University, Columbia University, University of Chicago, University of Illinois, and Northwestern University. Research support was provided by the University of Illinois Research Board, the Bureau of Economic and Business Research, and the National Science Foundation (SES 83-09211).

ABSTRACT

This paper makes explicit the linkages between the Mississippi Bubble in France, the South Sea Bubble in England as well with the aftershocks in Amsterdam and Hamburg during the years 1719 and 1720 by using semi-weekly exchange rate data that were published regularly throughout this period. These have never been used before to analyze either the dynamics of the two major bubbles or the linkages between them. We then use daily price data for the *Compagnie des Indes* in France, and the South Sea Company as well as the Bank of England and East India Company in England select and estimate the appropriate ARIMA models for different subperiods.

They suggest very strongly that portions of the Mississippi Bubble may be rational bubbles although it is as likely they reflect the manipulation of market fundamentals; that the South Sea Bubble was clearly a rational bubble but only for South Sea stock and not for Bank of England or East India Company stock; and that the Dutch bubbles were most likely rational but broken more by monetary reforms in France and reorganization of the South Sea Company in England than by their internal dynamics.

> We are now to enter upon the year 1720; a year remarkable beyond any other which can be pitched upon by historians for extraordinary and romantic projects, proposals, and undertakings, both private and national; ... and which, ... ought to be had in perpetual remembrance, not only as being what never had its parallel, nor, it is to be hoped, ever will hereafter; but, likewise, as it may serve for a perpetual memento to the legislators and ministers ... never to leave it in the power of any, hereafter, to hoodwink mankind into so shameful and baneful an imposition on the credulity of the people, thereby diverted from their lawful industry. (Adam Anderson, *Origin of Commerce*, v. 3, pp. 91-2.)

The Mississippi Bubble in France, the South Sea Bubble in England, and similar bubbles in Holland and Germany during the years 1719 and 1720 were parts of the first international stock market speculative boom and bust in capitalist Europe. The legacy of these episodes was substantial. The Bubble Act of 1720 in England limited the use of joint stock corporations until well into the nineteenth century; the French collective memory of John Law and his Banque Royale meant "there was hesitation even in pronouncing the word 'bank' for 150 years thereafter;"[1] and, of course, they gave us the word "bubble" for describing purely speculative movements in asset prices. These are the subject of a growing literature in modern macroeconomics.[2] It is useful to present and analyze as clearly as possible these classic bubbles in light of this recent theoretical literature, useful not only for understanding better the economic history of the

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[1] Kindleberger (1984), p. 98.)

[2] E.g., Blanchard and Watson (1982), Diba and Grossman (1983, 1984, and 1985), Flood and Garber (1982), Shiller (1984), Tirole (1982), and West (1984 and 1985).

eighteenth century but also for grasping its significance for economic theory. It is intrinsically interesting for economic theory to observe the activities on capital markets when they were in a relatively pristine state. The task of quantitative analysis and theoretical understanding is aided by the existence of extensive data resources that modern economic historians have just begun to exploit.[3]

Our results, presented in detail below, give a somewhat different interpretation of these Protean events than in the literature currently available.[4] We regard the Mississippi Bubble in France, the South Sea Bubble in England, and the later bubbles in the Netherlands as part of the same historical process. More accurately, each was a replay of the same economic game. The game in each case was to drive up the nominal values of shares in a given joint-stock corporation. The specific techniques used will be described below when discussing the Mississippi bubble since these were the same that were used in the South Sea and Dutch bubbles. The game was confined by fiat to one company (*Compagnie des Indes*) in the

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[3] E.g., McCusker (1978); Mirowski (1981); Neal (1977), (1983), (1985a), (1985b); Parsons (1974); Riley (1980).

[4] Lengthy works by Levasseur (1854), Harsin (1928, 1934, 1935), and most recently, Faure (1977), have covered the Mississippi Bubble in detail. The best analytical treatments available to date in English are by Hamilton (1936-37; 1967; 1969) and Minton (1975) is a useful narrative.

Carswell (1960), Scott (1910), and Dickson (1967) have discussed the South Sea extensively: Carswell the often humorous socio-political aspects; Scott, the dry but enlightening corporate and financial subtleties; and Dickson the historical background as well as the technical specifics of stockjobbing in the various subscriptions. All three accounts, in turn, rely very heavily on Adam Anderson's discussion in his *Origins of Commerce* (1801).

case of France; in England it was also concentrated on one company (the South Sea Company) in practice as will be demonstrated below. The game was finally dissipated when it was spread over a number of competing companies in the various provinces and cities of the Netherlands.

The participants in each game can be divided usefully into "insiders" and "outsiders". Insiders possessed superior information on what the actual prospects of the company or companies were and had earlier access to information on changes in capital authorized and privileges to be granted or not. The most important information they had which was never available to outsiders was about the actual number of shares that had been issued.[5] Nevertheless, they had to share their superior information with the outsiders since they changed the price of the stock of the company in question when they acted upon it. Moreover, insiders were subject to increasing constraints over the course of a bubble by their commitments to political patrons and supporters.

Outsiders, in turn, could be divided usefully into "speculators" and "suckers". Speculators are the most interesting participants in the game from an economic viewpoint. By reacting alertly to price signals, they could reasonably expect to make money by buying any time during the bubble so long as they sold out before the collapse. It would be rational for them to buy in while prices were rising and to sell out while prices were falling, i.e.,

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[5] Scott (1910-12) makes this the focal point of his analysis of the South Sea Bubble; Levasseur (1854) mentions it as a contributory factor but Faure (1977) places more emphasis on it for the Mississippi case.

first to make the rise and then the fall of price greater than it would be otherwise. We argue that at least the Mississippi and South Sea bubbles were examples of this kind of "rational bubble."

Of course, any speculator could look rational, even smart, if he had the benefit of the historical retrospect we enjoy today of the actual course of prices, and it is not difficult to identify periods during which such prescient speculators could have become very wealthy. Did such speculators actually exist, did their actions affect prices as we would expect in a "rational bubble", and were they anything but randomly lucky? We lack records of who bought how much and when and at what price for any of the bubble stocks. But we do possess evidence of reciprocal price fluctuations in the most important intervening asset available to speculators. Its price movements can be used to "mark" when some very important speculators entered each game and left it.

This is the course of foreign exchange, which in this early period proved remarkably responsive to international capital flows. By identifying characteristic "signatures" in the course of exchange rates that mark capital flows in the eighteenth century, we can date within three days when sophisticated speculators entered and left the various games. If these periods of play, in turn, correspond to periods of price accelerations when it would be profitable to buy long while the periods of recess correspond to periods of price decelerations when it would be profitable to sell short, then we have evidence that at least some participants in a given bubble were

rational. This does not by any means imply that the bubble activity was rational in some social sense, nor, interestingly, does it imply that the insiders themselves were rational in the strictest sense.

We draw explicit linkages between the two major stock market crises of 1719-20 and the aftershocks in Amsterdam and Hamburg using semi-weekly exchange rate data that were published regularly throughout this period. These have never been used before to analyze either the dynamics of the two major bubbles or the linkages between them. Though there has been extensive study of the two bubbles individually, there has been little investigation of the links between them, much less the links with the later bubbles in the Netherlands.[6] So the data we present in the various charts from both Paris and London represent a unique overview of each stock market bubble and the direct linkages between them. The ARMA

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[6] Scott and Carswell give subjective statements about the movement of the speculation in Europe. Kindleberger (1978; 1984) mentions briefly a transmission of the speculative mania while Ashton (1959) does take a short but close look at the transfer of capital between London, Paris, and Amsterdam and the resulting effects on English exchange rates. Adam Anderson, who was a clerk for the South Sea Company at the time, when writing his account much later in the century mentioned the presence of foreigners in both Paris and London during the height of each bubble. But he drew only parallels between the two and made no explicit links. (Anderson, v. 3, pp. 79-123.) John Law made an explicit comparison of the two episodes in 1721, drawing conclusions very much to his favor, but never addressed the issue of direct financial linkages between them. (Harsin, 1934, v. 3, pp. 198-235.) Luethy (1959) discusses the role of Geneva investors in both bubbles. Sayous (1937; 1940) the role of Dutch investors in each and the effect of the bubbles on the Netherlands; Groeneveld (1940) and Wilson (1941) the role of Dutch investors in English funds during this period and after. Dickson (1967) does the most thorough job of making the links, but he relies on contemporary newspaper reports of bullion shipments and exchange rate movements for his quantitative data. While he reproduces fortnightly prices of stocks from Castaing (p. 139) the only exchange rate he gives is that on Amsterdam.

estimations for the daily price data from the Mississippi and South Sea cases also represent the first empirical effort at characterizing the course of these bubbles in terms of the events in the foreign exchanges.[7]

The remainder of the paper is divided into four sections. The first describes the exchange rate data and the analytical framework we use to apply it to the various bubble episodes. The second part investigates the Mississippi Bubble and the "system" of John Law from May 1719 until November 1720 when Law left France incognito and in disgrace. The third section examines the South Sea bubble in the context of not only foreign capital movements but of the existing English stock markets and the chief competing domestic securities. The final section extends the analysis to the flows of foreign capital from England to Holland and Hamburg in the summer of 1720 and their return to their countries of origin. This occurred in the autumn as the Dutch bubbles broke, Law's system ended formally in France, and the English began to re-organize the South Sea Company. The legacy of French, English and Dutch bubbles was the continued disturbance of the international money markets into 1721. None had the happy endings one might hope for, but in this paper we concentrate on the bubbles rather than the aftermaths.

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[7] Parsons (1974) analyzes daily movements of stock prices on the London Stock Exchange in terms of weak tests of market efficiency during the South Sea Bubble but ignores the foreign exchanges or questions of rational bubbles.

I

Using quotes from the *Course of the Exchange* of John Castaing for information on exchange rates, gold, and stock prices, we can chart the progress of this first European-wide stock mania. Our data are twice-weekly quotes from the *Course of the Exchange* covering a period from April 1719 through December 1720. The starting point is one month before the Mississippi Bubble starts, and the finishing point is the end of the South Sea and Amsterdam Bubbles and the trough of the ensuing financial collapse in England. Since the dates on the *Course of the Exchange* are quoted in the Old Style (O.S.) or Julian calendar, all dates listed in this paper will be based from this calendar, even though both Amsterdam and Paris were using the New Style (N.S.), or Gregorian, calendar. Shown in Charts 1-3 are four exchange rates (three of which are compared with intermittent quotes from the Paris exchanges), and the price of gold. The exchange rates are the London on Paris exchange rate, measured in French crowns or three livre tournois per pence sterling; the London on Amsterdam rate, in schellingen banco per pound sterling; the Paris on Amsterdam rate measured in schellingen banco per three livre tournois; and the London on Hamburg rate, in schilling banco per pound sterling. Unless otherwise stated, these are two month usance rates.

While each exchange rate series has its peculiarities, all show periods of sustained rises or falls, and all are marked by occasional "blips" -- a sudden rise or fall followed quickly by a reversal. A sudden appreciation

of a particular currency followed by a full depreciation back to the normal exchange rate usually signaled a scramble for liquidity in the country of that currency. Since short term liquid assets were few, the scramble would focus on existing bills of exchange. That is to say, for any movement from one capital asset to another in any of the European countries at this time, bills of foreign exchange were the dominant intervention asset. As soon as letters from the country scrambling for liquidity had reached the merchant correspondents abroad and fresh bills had been authorized, the exchange rate would revert to its equilibrium level (which might, of course, not be the previous level given the currency and credit manipulations of this period). Thanks to the sedate pace of business correspondence relative to the posting of exchange rates semi-weekly at the Royal Exchange in London, the time series for each currency in this period show characteristic "signatures" when capital market disturbances occurred.

We shall call this the "Ashton effect" since T. S. Ashton describes it in detail as one of the statistical indicators of financial crises in the eighteenth century.[8] While one sign of impending crises was often an adverse movement in the foreign exchanges, a sure sign of an actual scramble for liquidity was this sudden appreciation. Ashton notes that the same thing occurred in the summer of 1914 when, briefly, there appeared to be a flight from the dollar to the pound. A depreciation in a currency's rate following the Ashton effect may overshoot the previous rate, in which

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[8] Ashton (1959), p. 113. Ashton gives credit, however, to Jacob Viner for the explanation of this non-intuitive result.

case it indicates a capital outflow. This overshooting of the exchange rate we will call the "Kindleberger effect". It enables us in combination with the Ashton effect to state where foreign capital flows are going and from whence they are coming at the end of any particular speculative episode. Kindleberger lays special emphasis on the destabilizing consequences of speculative capital movements from one financial center to another and has illustrated his argument with historical episodes dating from the 1719-20 bubbles through the late 1970s.[9]

Examining the London-Paris series in Chart 1, we first note a small blip in the spring of 1719. This is easily overlooked, given the violent fluctuations to come, but it is interesting that this coincides with the start of Law's system in May 1719 with the formation of the *Compagnie des Indes*, the general trading monopoly company for France, on the basis of Law's existing *Compagnie d'Occident.* The existing literature suggests that money left London and Amsterdam for Paris in the late summer of 1719. Scott writes that "Paris became the Mecca of speculators of Europe."[10] Carswell cites a report that 30,000 foreign speculators had entered Paris in the fall of 1719.[11] The graph of the London-Paris exchange rate shows a slight appreciation of the livre in mid-August, but the increase is small relative to the background noise of the previous two months. In September,

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[9] Kindleberger, (1978) is the best exegesis of his argument in the historical perspective.

[10] Scott, I, p. 403.

[11] Carswell, p. 101.

at the height of the capital flow to Paris, the exchange rate actually depreciates!

The answer to the apparent paradox is that Law fostered the boom through a systematic money inflation. (See Table 1.) The Paris exchange rate started to depreciate in late October 1719 and continued to March 1720. This depreciation was due to a slowing down and reversal of the capital inflow along with the continued increase in the issue of bank notes and debasement of the livre by Law. In late November and early December 1719 one can find a sharp appreciation of the pound with respect to the guilder and the livre. Because of the suddenness of the movements, and the sharp drop in the price of French stock, we infer that a fair number of speculators took their profits and departed for England. Scott estimates that 500 million livres in bullion had been carried out in late 1719.[12]

When the share quotations for the *Compagnie des Indes* had reached Law's target level of 10,000 livres (a twenty-fold increase) in the middle of November (O. S.), the issuance during the next week of 30 million livres worth of new shares stabilized the price.[13] At the end of that week, stock market speculators left Paris for London.

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[12] Scott, p. 404.

[13] Faure, p. 269, says there were 30 million new shares, "*titres*", issued but this would imply nearly 300 billion livres worth. His source, (Dutot, v. II, pp. 257-8), on the other hand, only says "*30 millions*" without specifying "*titres*" or "*livres*". Dutot's summary of the total value of *Compagnie des Indes* stock at the end of November, however, is only 4.782 billion livres. The number of new shares issued in mid-November, therefore, must have been only 3,000; their approximate market value 30 million livres.

Another exit occurred in early February. On February 12, 1720 Law halted all dealings in stock, foreign exchange, and bank notes in an attempt to combat inflation and speculation. The price of Mississippi shares plummeted. At the same time, the English Parliament approved the South Sea Company's proposal for funding a large part of the National Debt. So money left France and headed for England.

Popular pressure forced Law to reopen the Paris stock market on February 23, with the purchase and sale of unlimited quantities of shares priced at 9000 livres, and to re-open the offices where billets de banque could be converted to silver. This restored the stock market boom, but speculation now took place in the paper currency, the *billets de banque.* The reaction of the Paris-London exchange rate at first was a case of the Ashton effect. As speculators could not convert their shares of Mississippi stock directly into specie but only into depreciating paper currency on the French market, the uncertainty of the situation led to an appreciation of the livre as holders of English bills of exchange on Paris sold these assets at a discount. Once the stock market in Paris reopened, the livre depreciated sharply, signaling the exodus of speculators.

The stock market gyrations continued in France with mostly domestic speculators until the middle of May 1720. On May 10, in a fit of desperation, Law announced a deflationary decree, again in an attempt to save his system. Convertibility of bank notes to specie was to end. The official price of shares of the *Compagnie des Indes* was dropped to 8000

livres with a target price of 5000 livres by December 1. In response, the French exchange-rate moved as it had in February, with an initial appreciation followed by a sharp depreciation. However, the graph overstates the appreciation of the livre since the quotes in London from May 13 through May 20 are "at sight" instead of the customary usance of two months. Therefore, they incorporate the sight premium as well as any appreciation during that week. Afterwards, the quotes were again at usance but the Kindleberger effect, or overshooting of the previous level for the exchange rate, shows up clearly nonetheless. Whether the remaining speculators, French and/or foreigners, left France for England for more profits or whether the French nobility took their specie to safer quarters, this depreciation signals a capital outflow.

From the deflationary decree in May (which Law lifted a week later, again under public pressure) onward, currency debasements and increased bank note issues resulted in a continued depreciation of the livre. The bankruptcy of July 6 (O.S.) of the *Banque Royale* shifted speculation in France from shares in the *Compagnie des Indes* to billets de banque which declined in value until the exchange market in France closed in September 1720. The sharp appreciation of the livre in late September was the result of more traditional bankers regaining power and causing a repatriation of gold into France.

Turning to Chart 2, the Amsterdam-London exchange rate, we can pick out the repercussions of the French speculative movements as the

relative importance of London and Amsterdam shifts as either sources for capital inflows to France or as destinations for capital outflows from France. Carswell has linked the speculative fever of the Mississippi and South Sea Bubbles only in late spring of 1720:

> Buying orders for South Sea stock poured into London from Holland, 200,000 pistoles arriving in one consignment from Amsterdam towards the end of April.[14]

> And to London that spring were coming a great many of those who, only a few months before, had been crowding the rue Quincampoix (French stock market).[15]

Looking at the Amsterdam-London exchange rate and the graph of South Sea stock prices, however, we can see that an influx of foreign speculators came to England in March. Both the price of South Sea shares and the English pound appreciated throughout the spring of 1720.

By the first half of May both South Sea stock and the London-Amsterdam and London-Hamburg exchange rates leveled off. This was the lull before the next storm, however. On May 20 the South Sea Company announced more conversions of debt, long-term and short-term annuities at 375 pounds, and granted loans to aid buyers of additional stock. The pound appreciated sharply as foreigners entered the market. After these large capital inflows in the spring of 1720, the pound began to depreciate in the summer. This signals a reversal of the capital flow, first to Amsterdam,

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[14] Carswell, pp. 147-8.

[15] Carswell, p. 143.

then to Hamburg. Carswell states "Amsterdam (in) June and July saw a crop of native promotions . . . . Others were on the way to Hamburg, where the Exchange was crowded from morning to night.[16]

One can explain the sharp fluctuations that highlight this June-July depreciation of the pound as temporary slowings in the capital outflow. Two events in the story of the South Sea Bubble seem to be responsible. The first sharp rise came as the result of another group of subscriptions of South Sea stock sold between June 16 and June 22. The company offered 5 million pounds in stock at 1000. This issue pumped 4.75 million pounds into the market, running the total to 11.4 million pounds since April. The second rise, found in early July, is not associated with an issuance of stock but may be due to the French connection. The price of South Sea stock was hovering around 850 or more and had not yet begun its final plummet. While the bankruptcy of the *Banque Royale* on July 6 (O.S.) in France caused both the pound and the guilder to appreciate relative to the livre, it appears that flight capital from France headed more toward London than toward Amsterdam.

The timing of the capital flows to Amsterdam and Hamburg are illustrated by the convergence of the London-Amsterdam and London-Hamburg rates in June. The pound depreciated relative to the Dutch schellingen banco while the pound fluctuated around the pre-bubble level relative to the German schilling banco. This implies a capital outflow

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[16] Carswell, pp. 164-165.

directed toward Amsterdam. In July the spread between the rates widened as the pound depreciated relative to the schilling banco, signalling a capital flow increasingly headed towards Hamburg.

The sharp rise and fall in Amsterdam and Hamburg rates in mid-August is the Ashton effect, signalling the financial panic that had begun. This was produced unintentionally by the directors of the South Sea Company themselves, the real insiders in the bubble that had occurred previously. Worried that other companies and projects were draining precious money from their operations, the company invoked a writ of *scire facias* on August 18 which tried to close some of these companies on a legal technicality the company itself violated. The price of South Sea stock dropped sharply from the last half of August through the middle of October. On September 24 the Sword Blade Bank suspended payments, intensifying the scramble for cash in a tight money market.

A brief respite in the tight money market came in mid-October as the pound appreciated sharply and gold prices plummeted. These movements reflected the collapse of the Dutch boom in October and the arrival of 100,000 guineas in gold from Holland at this time.[17] This easing was short-lived. The English financial system faltered and remained precariously weak for the last three months of the year. As can be seen on the Amsterdam exchange-gold price graph, a depreciated pound and high gold prices indicate a sharp depreciation in bills of exchange and bank

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[17] Scott, III, p. 323.

notes, respectively. A substantial widening between sight and usance exchange rates on Amsterdam, over ten times higher in October 1720 than in 1723, indicates that interest rates in the international money market were very high.

II

There has recently been an interest in the possibility of rational bubbles in asset prices. Were the Mississippi and South Sea episodes just described rational bubbles or not? If we were to follow the example of West (1984, 1985) and test for consistency of two separate estimates of the set of parameters needed to calculate the expected present discounted value of a given stock's dividend stream, it is clear we would find the existence of speculative bubbles in the prices of both Mississippi and South Sea stock. This is clear from the relative stability of dividends actually paid out compared to the volatility of the stock prices. But West's techniques are not intended to isolate rational bubble episodes within a limited time period as we would like to do here. The evidence of contemporaries marveling at the crowd psychology displayed in the narrow confines of Rue Quincampoix or Exchange Alley or Kalverstraat is certainly consistent with the crowd behavior explanations recently revived by Shiller (1984). And the exchange rate evidence we have presented strengthens Kindleberger's case (1978) for using these episodes as primary examples of his thesis that most price bubbles are international disturbances transmitted among two or more centers that lead to irrational and overzealous trading in each.

But can the price movements also be explained by movements in market fundamentals as Flood and Garber (1980, 1982) would argue? It is even more true for the eighteenth century than the twentieth that we lack data on the commonly specified determinants of stock prices comparable in quality and frequency to that available for stock prices alone. We are forced to improvise some alternative tests that will take maximum advantage of the data we do possess. While the results will only be suggestive, not definitive, we believe they suggest very strongly that portions of the Mississippi Bubble may be rational bubbles although it is as likely they reflect the manipulation of market fundamentals; that the South Sea Bubble was clearly a rational bubble but only for South Sea stock and not for Bank of England or East India Company stock; and that the Dutch bubbles were most likely rational but broken more by monetary reforms in France and reorganization of the South Sea Company in England than by their internal dynamics.

Rational bubbles appear ultimately to depend upon the co-existence for a brief period of time of two distinct classes of traders: perhaps distinguished by the quality of the information they hold, perhaps by their attitude toward risk, perhaps by their time horizons. As we shall see, all these elements can be found in both the South Sea and the Mississippi bubbles. But the two classes of traders operating in the same way but at different times left their distinctive mark on the course of stock prices only in certain time periods.

In the theoretical literature of bubbles, a bubble occurs when the expected rate of change in the price of an asset is an important factor in determining the current market price[18]. There is no question rates of change in asset prices changed long enough and sharply enough to have affected expectations of investors in both France and England in 1719 and 1720. (See Figures 4-5.) The real question is whether these bubbles can be considered to be rational or not. The type of rational bubble that best fits the Mississippi and South Sea cases for the internationally mobile speculators we have observed above is a discounted martingale.[19] One can represent the return above the market fundamental by the following difference equation:[20]

$c_t = ((1+r)/q)c_{t-1} + z_t$ with probability q;

$c_t = z_t$ with probability 1-q;

$E(z|I_{t-1}) = 0$; c = return above market fundamental; r= period discount.

The participants see a capital gain above the market fundamental in the next period if the bubble continues or a return to zero expected speculative gain if the bubble bursts. The longer the bubble lasts the higher

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[18] Flood and Garber, p. 275.

[19] A martingale is a repeated series of bets where the stakes are raised after each loss so that with a positive probability of winning on each bet, the gambler may eventually win. The original term refers not to a bird, but to piece of horse harness designed to keep the horse's head down while running or pulling a load.

[20] Blanchard and Watson, pp. 297-298.

the capital gain must be to compensate for the greater likelihood of a market crash. According to Tirole (1982), a rational bubble with a finite horizon must meet two further stipulations. Expectations must be myopic; sequential traders only look at the expected trading options in this period and the subsequent period. Law initiated, and the South Sea directors imitated, the practice of paying for stock subscriptions in monthly, later changed to quarterly, installments. This had the desired effect of creating precisely this kind of myopia by the first purchasers of the new stock issues. Second, there must be several "generations" of traders entering the market.[21] The device of issuing several subscriptions of additional stock was an essential element in the capital expansion of both the *Compagnie des Indes* and the South Sea Company. This also created, as we noted on the foreign exchange graphs, successive "generations" of outside speculators. From the theoretical viewpoint, then, sufficient conditions appear to be in place to warrant asking whether each episode was a rational bubble or not.

From a strictly historical viewpoint, the question is worth asking as well. The South Sea episode clearly contained a swindle by a subset of the directors of the company and the only disagreement among historians arises over whether this was the primary element in the situation or not. But the System of John Law contained such a great mixture of elements and controlled directly so many of the conceivable policy variables it has remained a fascinating question whether it could have worked in part or

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[21] Tirole, p. 1170, p. 1175.

with some minor modification. Faure distinguishes two parts to it: *le plan sage*, and *le plan fou* and argues that the "wise plan" could have worked very well if left on its own.

In our summary of the System below we rely essentially on the data and analysis presented by Faure (1977). Faure's study in turn rests heavily on the previous work by Harsin, but supplements it with important new data on the share prices of the *Compagnie des Indes*, exchange rates in Paris on both Amsterdam and London, and the market values of bank notes issued by the *Banque Royale*.[22] These data are incorporated into Chart 4 and Table 2 below. All these studies emphasize, however, the singularity of the French experience rather than, as we did above, the linkages it had to the British experience. The role of foreigners in these accounts was to come to Paris and marvel, rather than to transmit French economic disturbances elsewhere.

After a large-scale cancellation of government debt at the beginning of the Regency of Louis XV, the crown still found it impossible to pay interest on the remaining debt already discounted 75 percent. Desperate for solutions, the Regent, the Duke of Orleans, fell under the sway of a brilliant Scottish financier, John Law. In May 1716, Law founded the *Banque generale*, the success of which laid the basis for the greater enterprises to come. In August 1717 Law formed the *Compagnie d'Occident*

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[20] Faure also adds his own delightful appraisal of the high politics of the era as acted out by principals possessing an amazing variety of sexual idiosyncrasies!

which, like the South Sea Company in its original charter of 1711, took over some of the national debt for special overseas trading privileges. Citizens and foreigners could exchange their holdings of government debt for stock in the company. The original nominal capital, par value 500 livres per share, was 100 million livres. The initial market value of the stock was below par at 300 livres. In December 1718 Law converted the *Banque generale* into the *Banque Royale* whose notes, denominated in either gold *ecus* or in silver *livres* now became the medium for tax payments. In May, the *louis d'or* was devalued relative to the *livre* so that the *billets-livre* became the preferred form of money for the public to hold. Also in May 1719 the *Compagnie d'Occident* was expanded to include the monopoly of trade with India and China and was renamed the *Compagnie des Indes* with a new issue of 50,000 shares. In the summer of 1719, Law put the remaining elements of the System into place, acquiring the right of the Company to mint coins and assuming the farm of the indirect taxes.

The decrees of August 16-20, 1719 (O.S.) completed the formation of the System with a bold step toward fiscal reform -- the suppression and reimbursement of the *rentes* and many of the offices that had been sold in the previous two decades in order to raise money. The reimbursement took place in *billets de banque* at the offices of the Company which had to offer to the reimbursees as well as all other holders of existing government debt either bearer shares in the Company with 4% annual dividends or "contrats de constitution de rente" which carried a fixed return of 3%, the same reduced rate the government paid the Company on the debt it held. Luethy

considers this the fatal flaw in the System since the reimbursements required large new issues of paper money.[23] Faure, on the other hand, believes the reimbursees would have used their *billets de banque* to purchase one or the other of Company's obligations to avoid further depreciation of their assets. Based on the increased revenues projected from the tax farm on indirect taxes now controlled by the Company for the next seven years as well as revenues from the monopoly of the mint, these obligations, "*actions rentieres*" could have been a very attractive, blue chip investment so that in effect the elimination of direct taxes, offices, and the *rentes* could have been funded into the permanent capital stock of the Company.[24] As it was, Law proceeded to his *plan fou* with three successive new issues of capital stock (the fourth, fifth, and sixth issues) in the Company on September 2, 17, and 21 in 1719 (O.S.).

These shares were issued at a face value of 5,000 livres each with a promised dividend of four percent. Since the first three issues of shares had had face values of 500, 550, and 1,000 livres, the possessors of these *meres*, *filles*, and *petites filles*, as they were popularly called, profited from enormous capital gains. The existing holders of government debt, however, were not accorded any priority in purchasing these new shares so they were forced to buy them at existing market value. This meant they had to hope for further capital gains on their shares in the Company if they were to

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[23] Luethy, I, p. 317.

[24] Faure, pp. 225-28.

regain some of the losses they had already suffered on government debts. The third step in Law's plan was to raise the market value of the shares to 10,000 livres, this in order to reduce the effective rate of interest to two percent.[25]

To facilitate speculation, or in his view to mobilize the necessary capital, Law took the following steps:

> 1) he divided shares into fractions small enough for modest investors to be able to purchase them;
>
> 2) provided for installment payments, 10% per month, and further provided the first two months could be deferred to the third. This meant December and March were the months of reckoning;
>
> 3) provided loans from the Bank on the security of shares, even if only partially paid for;
>
> 4) starting on December 19 (O.S.), opened an office for the purchase and sale of shares in the Company;
>
> 5) later fixed the price of each share at 9,000 livres.[26]

All these steps can be seen as establishing the rules for a game the object of which is to increase the price of shares of the *Compagnie des Indes* to 10,000 livres. Did the price in fact follow a discounted martingale during a period that we believe outside speculators entered and left using foreign exchange as their intervention asset? The effective period turns out to be from mid-July 1719 to the end of November (N.S.) but Faure's daily

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[25] Faure, pp. 232-3. Faure cites a number of Law's writings from 1715 to 1724 in which he repeats this sacrosanct number of 2%.

[26] Faure, pp. 233-234.

price data do not begin until August 1. Our empirical exercise is to take the first differences of the natural log transforms of the daily price quotes available in Faure, and then to search for a detectable time series pattern that is significantly different from white noise or a random walk. This is equivalent to a weak test for market efficiency in the sense of Fama. For purposes of claiming market efficiency, such searches for time series patterns should yield (0,0) autoregressive, moving average models -- i.e., there is only "white noise" or random, unpredictable movements in the price changes. This is what we hope to find during periods before and after bubbles. During the bubbles, however, we should find a predictable movement, preferably described as an autoregressive movement with positive coefficients. This would be consistent with two or more classes of traders anticipating further price increases with some probability greater than zero. It may also be consistent with a steady growth process in market fundamentals, but changes in market fundamentals during the brief periods we are analyzing here are more likely to show up as moving average processes. A predictable pattern that is best described as a moving average process, then, may be consistent with a rational bubble, but it probably indicates instead an innovation in market fundamentals.[27]

Taking the period from August 1, 1719 through November 29 (N.S.) for prices of the second subscription of shares of the *Compagnie d'Occident*, (the so-called *filles*), we find that the best fitting ARMA model is a (5,0).

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[27] Moving average processes are generally found, for example, when ARMAs are estimated on data series with missing entries, entry errors, or outliers.

This is with daily data but ignoring gaps that occurred frequently not only regularly for each Sunday but also irregularly for religious and state holidays. If missing values for the holidays are filled in either by naive extrapolation from the last quoted price or by linear interpolation in the logarithms of the prices before and after the holidays, then a (0,2) ARMA is selected. Checking for the best model on the run of prices from November 20, 1719 to March 1, 1720 we found it to be a (0,0). If we take the first results, they may indicate that a rational bubble with as many as five separate classes of traders was in progress during the period that the significant price rise took place in shares of the *Compagnie d'Occident* and that an efficient market ruled until the System began its collapse in Spring 1720. This would conform with Faure's judgement that "la folie de Law...est une folie raisonnee et raisonnante."[28] If we prefer to take the (0,2) ARMAs we find when some allowance is made for the missing observations during holidays, however, then they indicate that Law was frequently intervening directly and indirectly in the market fundamentals to create the rise in prices. This interpretation conforms more to the more traditional analyses of Luethy and especially Levasseur.

III

Irrational bubbles are those in which the relationship of an asset to its market fundamental simply breaks down because of overzealous trading

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[28] Faure, p. 233.

or an unrealistic appraisal of the value of the stock. Kindleberger (1978) espouses this view of market bubbles. In this scenario a shock to the economic system changes the perceived profitability of a particular enterprise. Coupled with easy credit, a boom ensues. Speculation spreads to parts of the public that normally avoid playing the market. These new entrants have little knowledge of the market and thus add an element of irrationality into it. Kindleberger's analysis suggests a mania that spreads to other assets -- shares in all sorts of joint stock companies, real estate and a madcap variety of alternative assets. The South Sea Bubble fits his schema as if tailor made (by the Mad Hatter, of course).

In our investigation of the South Sea Bubble, we have adopted essentially the analysis and appraisal made by Dickson. The motivation for the South Sea scheme was essentially the same as for the Mississippi Bubble -- to refinance the immense debts accumulated by the government during the War of the Spanish Succession.[29] And the mechanics of the scheme were very similar. In exchange for their annuities, holders of the existing government debt were offered new South Sea Company stock which promised capital gains. Two-thirds of the annuity owners made the exchange, in response to increasingly attractive terms offered by the directors of the South Sea Company. These in turn were divided into an inner ring of prime movers privy to most of the details of each successive

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[29] Dickson, pp. 91-2. Cf. Hamilton (1947).

stage of the scheme and the remainder of the Directors who probably were not.

The operations consisted of four new issues of stock which were made on April 14, April 29, June 17, and August 24, 1720 (O.S.). These could be purchased for one-fifth down (1st and 4th issues) or one-tenth down (2nd and 3rd issues) with the balance due in equal installments spread over 16 months (1st issue), 32 months (2nd issue), 54 months (3rd issue) or 36 months (4th issue). With the last two issues, loans could be obtained from the South Sea Company itself for the market value of the South Sea shares held by a purchaser.[30] According to Dickson, the rise in price of the shares occurred in three spurts -- the second half of March, the second half of May, and during June. The first was due primarily to foreigner speculation moving from Paris to London, the second due to increased participation by Dutch investors and the beginning of loans by directors of the company on security of South Sea stock, while the third was due to an immense increase in loans on stock, on subscription receipts and on subscriptions made verbally.[31]

The same efficiency test used for the stock of Law's *Compagnie d'Occident* was implemented for the major three English stocks -- Bank of England, East India Company, and the South Sea Company -- using the daily price data from the *Course of the Exchange*. The results are listed in Table

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[30] Dickson, pp. 123-5.

[31] Dickson, pp. 140-43.

2. The best models are found for each stock in each of five separate sub-periods that can be distinguished by exchange rate movements. The first is the pre Bubble period for England, but the height of the Mississippi bubble in France. Both the South Sea stock and the Bank of England stock show evidence of disturbances but East India stock does not. The next period, January 19 - April 5, continues to show nothing for East India stock while a strong second order autoregressive process occurs for South Sea stock. This implies that different groups of market participants were using the same information at different times -- a band wagon effect with different players for different sets. This conforms to the type of situation Tirol posits as necessary for a bubble period and with Scott's portrayal of the market-rigging performed by the inner circle of South Sea Company directors. (No model was picked for the Bank of England stock since 2 1/2 weeks of observations are missing during the period they closed the transfer books to pay dividends.) In the following period, which is regarded as the height of the madness according to the historical accounts, neither East India or Bank of England stock showed anything but white noise and while the South Sea stock continued to have a strong autoregressive movement in its growth rate, it was a first order, rather than second order, process. The fourth period that is taken as the lull before the storm in the traditional accounts, however, shows marked disturbances for each stock. The post-Bubble period shows continued disturbances for East India stock, perhaps because the directors of that Company now began to make loans on the security of East India shares, but none for the South Sea Company stock.

During this period everyone knew that a reorganization and settlement of accounts would take place for the Company but no one knew what it would be until 1721.

Table 3 shows the best models and their estimated coefficients for South Sea stock during various sub-periods of the Bubble period when exchange rate signatures occurred. The strongest bubble process appears to be the period February 23 through June 15 in the sense that the coefficients are highest in this period for both lagged terms. An anomaly does appear in the period February 23 to May 16 when the best model is a (0,2) or second order moving average process rather than an autoregressive process. The explanation technically is that the first order term is very small in the AR process as well as in the MA process and the selection technique takes the lowest order AR model before it begins mixing in MA models. The explanation economically may be that in the early stages of the bubble the second generation investors were more important for getting the bubble underway. The "insiders" were clearly trying to get the "outsiders" into the game. Their maneuvers to accomplish this may be seen in theoretical terms as shifts in market fundamentals -- and therefore are as likely to create an MA process as an AR process. It is interesting that the coefficient for the second order term in the AR processess estimated for the various subperiods is relatively constant, ranging from 0.28 to 0.31, while the first order term is as low as 0.07 and as high as 0.21. This appears to be the statistical counterpart of the phenomenon reported by Dickson that the bubble kept gathering its own momentum so that the last two issues of stock were not at

the initiative of the inner ring of the directors so much as their response to the tremendous demand for new stock.[32]

Our conclusion that the bubble in South Sea stock was rational is strengthened by the fact that despite using the same procedures for identifying a rational bubble in Bank of England or East India Company stock, none was found for either in any of the five subperiods before, during, and after the South Sea bubble. While we have not examined prices of other assets such as land or buildings, Dickson makes the interesting observation that greatly inflated prices sometimes quoted for real assets during the height of the bubble were generally for payment in South Sea stock, implying that the price would have been much less if payment were made in cash or bank deposits.[33] If this is correct, then it is further evidence that the South Sea bubble was a rational bubble and not a response to changes in market fundamentals.

IV

We have used the movements in the foreign exchange rates to mark the entry and exit of outsiders. Although we distinguished initially between "speculators" and "suckers" within the "outsider" category, implicitly we put foreign outsiders into the speculator group and domestic outsiders into the sucker group. In fact, of course, foreigners and natives could be either

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[32] Dickson, pp. 126-28.

[33] Dickson, p. 147.

speculators or suckers and, as the discussion of the Ashton effect above demonstrated, both foreign and domestic speculators would find it most convenient to enter and exit the capital markets of the eighteenth century through the medium of foreign bills of exchange.

The dominant foreign group mentioned at the time in both bubbles were the Dutch, and contemporary accounts credited them with being extraordinarily shrewd in picking their moments to enter and to leave. In fact, English and Irish investors played an important role in the Mississippi Bubble. Luethy mentions the case of Jean Lambert, a director of the South Sea Company who came to Paris in August 1779 and who was expelled by Law in March 1720 under the charge he had remitted 20 millions pound sterling to London in order to break the French exchange rate.[34] French investors were active in the South Sea episode. Luethy describes the role of the Oglethorpe family, members of which moved freely between London, the New World, and the Jacobite court in Paris.[35] Hamilton (1967) gives details of the most amazing example of all -- John Law's short sale of £100,000 of East India stock in late summer 1719 at £180,000 for delivery in August 1720. This had to be covered in the summer of 1720 by buying East India stock at nearly double the agreed sale price. Law lost a fortune in this single bet and his London banker failed by the end of 1720.[36]

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[34] Luethy, p. 291.

[35] Luethy, pp. 294-5.

[36] Hamilton, (1967), pp. 275-6.

The depreciation of the Amsterdam and Hamburg exchange rates in the summer of 1720 shows that speculators, whatever their nationality, first took their money to Amsterdam in June and increasingly headed toward Hamburg in July. Groeneveld dates the first joint stock company proposal in the Netherlands on June 10, 1720 (May 30 O.S.). Another scheme was presented in late July and the remainder after September 12 (i.e., after the collapse of the South Sea bubble). Although the Dutch schemes followed as hard upon the English bubble as the South Sea had followed the French, this does not mean all the Dutch withdrew their funds from abroad and invested at home. Groenevelde gives many examples in the inventories of Amsterdam bankruptcies of holdings of South Sea as well as other English securities.[37] There are even orders dated the 10th and 13th of September (N.S.) 1720 from Portuguese Jews in Amsterdam, reputedly the shrewdest speculators of all, authorizing Joseph Henriques Junior in London to buy shares in the South Sea Company without limit.[38] Nevertheless, our evidence from the exchanges indicates that in September and October 1720 the speculators went home to London and Paris. There is only one brief respite in the decline of the exchanges in mid-October, apparently in response to an effort by the Bank of England to draw on its debtors in Amsterdam.[39]

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[37] Groeneveld, pp. 79-80.

[38] Groeneveld, pp. 124-5.

[39] Dickson, p. 151.

In sum, in all three episodes our exchange rate data have confirmed the importance of international movements of capital marked by Ashton-Kindleberger "signatures" in dating periods of price explosion, stagnation, and collapse. The suspicions of Dickson and Kindleberger that the bubbles were linked and that the stock mania was international in scope appear to be verifiable by quantitative techniques, although Kindleberger's argument that this was eventually irrational in the sense of becoming a general mania is not supported. A final note of caution must be sounded. Although the individual bubbles may have had significant periods of rationality, these did not coincide or even overlap. Given the disarray evident in the exchange rates for all three financial centers by the fall of 1720, it is clear that the immediate aftermath of the bubbles was disruptive to the economies of each country, although the longer run effects appear to have been minimal and even beneficial. But a normative evaluation of the bubbles is beyond the scope of this paper and the limits of our data set.

TABLE 1

ISSUE OF NOTES BY BANQUE ROYALE FROM DECEMBER 1718 TO APRIL 1720 (IN MILLIONS OF LIVRES)

Date of commission	Notes added	Total note issue
December 25, 1718	18	18
January 31, 1719	20	38
March 21, 1719	21	59
April 11, 1719	51	110
May 30, 1719	50	160
July 14, 1719	221	381
September 1, 1719	120	501
October 13, 1719	120	621
December 18, 1719	360	981
January 26, 1720	200	1181
March 15, 1720	300	1481
March 25, 1720	437	2195
April 20, 1720	362	2557

Source: Harsin (1928)

Note: At the start of this period, there were an estimated one billion livres in specie in the country and 148 million livres in *Banque Generale* notes outstanding.

TABLE 2
ESTIMATED ARMA MODELS FOR COMPAGNIE DES INDES STOCK DURING THE MISSISSIPPI BUBBLE

Time Period	Version 1[1]	Version 2[2]	Version 3[3]
	(n=78)	(n=103)	(n=103)
August 1 to November 29, 1719	(5,0)	(0,2)	(0,2)

[1] All missing observations (each Sunday, plus all holidays) were simply omitted, giving a compressed time series. This may be a valid representation if traders simply halted their expectations or if no new information occurred on non-trading days.

[2] The missing observations for holidays were interpolated naively by setting each equal to the last observation.

[3] The missing observations for holidays were interpolated linearly in logs.

TABLE 3
ESTIMATED ARIMA MODELS FOR BANK OF ENGLAND, EAST INDIA AND SOUTH SEA COMPANIES DURING THE SOUTH SEA BUBBLE*

Time Period	B of E[1]	EI Co.	SS Co.[2]
Sept. 4 - Nov. 18, 1719 (n = 65)	(0,3)	(0,0)	(0,1)
Jan. 19 - Apr. 5, 1720 (n = 67)	(-,-)	(0,0)	(2,0)
Apr. 20 - June 22, 1720 (n = 55)	(0,0)	(0,0)	(1,0)
June 29 - Aug. 31, 1720 (n = 55)	(0,3)	(0,2)	(0,2)
Sept. 4, 1720 - Dec. 15, 1720 (n = 89)	(-,-)	(0,5)	(0,0)

* The program searched for the "best" AutoRegressive model up to 5 lags on first differences of the natural logarithms of the stock prices. Then the addition of Moving Average models up to 5 terms for each AR model were compared. The one that minimized the expression:

$$\log(\text{sigma2}(t)) + 2*t/n$$

where sigma2(n) is the sum of squared residuals for the given model, n is number of observations, and t is the sum of terms in the AR and MA models, was then selected as the best model. (Hannen and Rissanen (1982))

[1] One missing observation for September 18, 1719 was set equal to previous observation. At this point there is a one time drop in price of Bank of England stock; without this, the estimated ARMA would be (0,0).

No ARMA is run for the period of the bubble, Jan. 19 - April 5, 1720 or the post-bubble period, Sept. 4 - Dec. 15, 1720 since many observations are missing (March 5 - March 23; Sept. 16 - 30) during these periods when the transfer books were closed for payment of dividends.

There was a run on the Bank in the period June 29 - August 31, 1720 (ARMA = (0,3)).

[2] The (2,0) ARMA during the Jan. 5 - April 20 phase had parameter values of 0.097 and 0.313.

The (1,0) ARMA during April 20 to June 22 phase had a parameter value of 0.48.

TABLE 4

COMPARISON OF ARMA MODELS FOR SOUTH SEA STOCK PRICE CHANGES IN DIFFERENT BUBBLE PERIODS

Time Period	Best Model	Estimated Coeffs.*
Jan. 19 - Apr. 5, 1720[1] (n = 67)	(2,0)	[0.099, 0.31]
Feb. 23, 1720 - May 16, 1720[2] (n = 71)	(0,2)	[0.095, 0.32]
Feb. 23, 1720 - June 15, 1720[3] (n = 97)	(2,0)	[0.2, 0.31]
Feb. 23, 1720 - June 22, 1720[4] (n = 103)	(2,0)	[0.21, 0.28]
July 5, 1720 - Aug. 17, 1720[5] (n = 37)	(0,0)	

* The coefficients of the ARMAs were estimated with constant term suppressed. The exact likelihood method of Ansley (1979) was used.

[1] Bubble period between exchange rate signatures.

[2] Bubble period between exchange rate signatures. Linear interpolation of natural logs for missing data on April 15, 18 and 19. When a (2,0) ARMA process (a close second choice to the (0,2)) was estimated for this episode, its parameters were: [0.07, 0.29].

[3] Bubble period between exchange rate signatures. Linear interpolation of natural logs for missing data on April 15, 18 and 19.

[4] Bubble period from exchange rate signature to data break. Linear interpolation of natural logs for missing data on April 15, 18 and 19.

[5] Post bubble period marked with exchange rate signatures. When a (2,0) ARMA process was estimated for this episode, its parameters were [-0.65, -.32].

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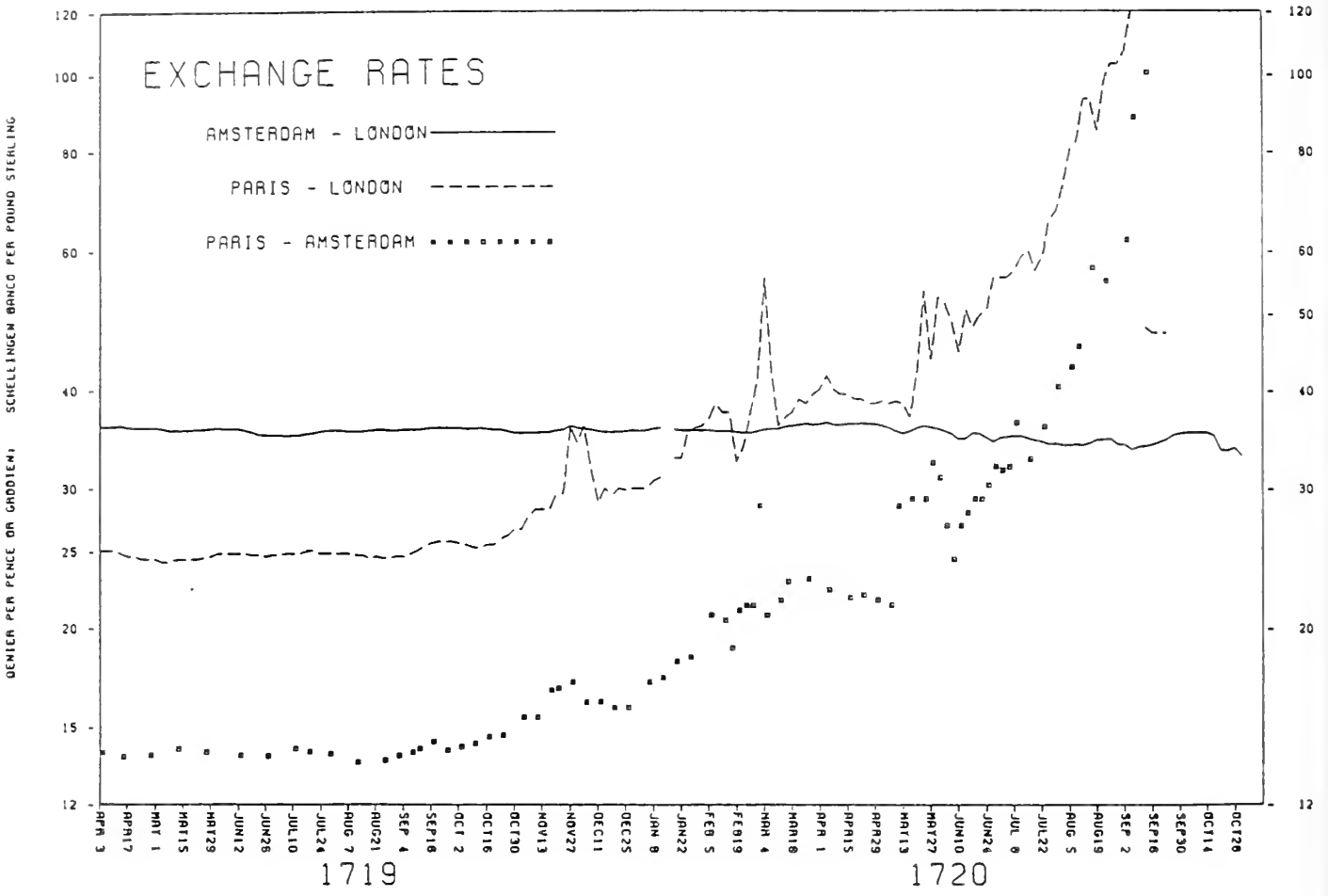

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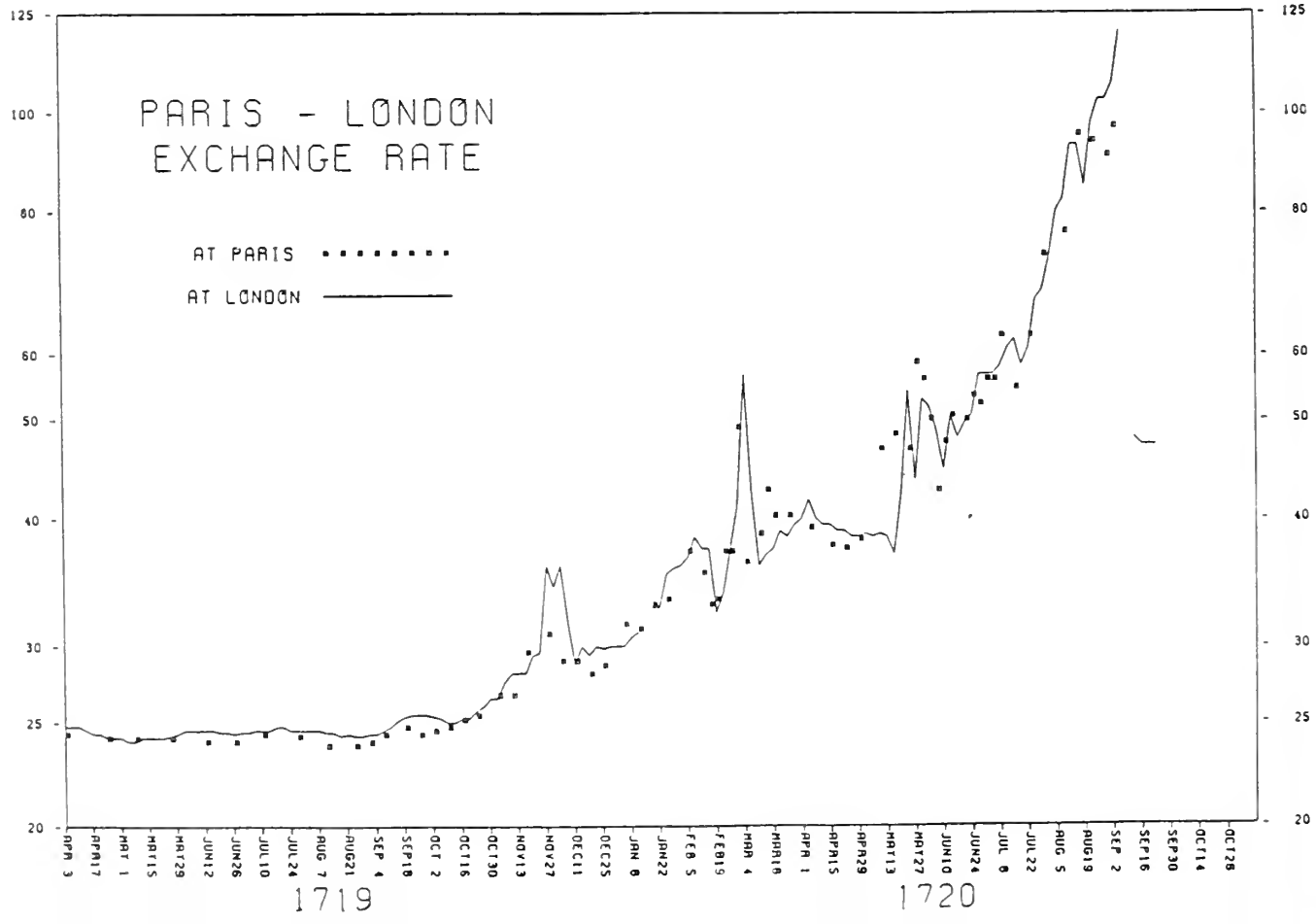
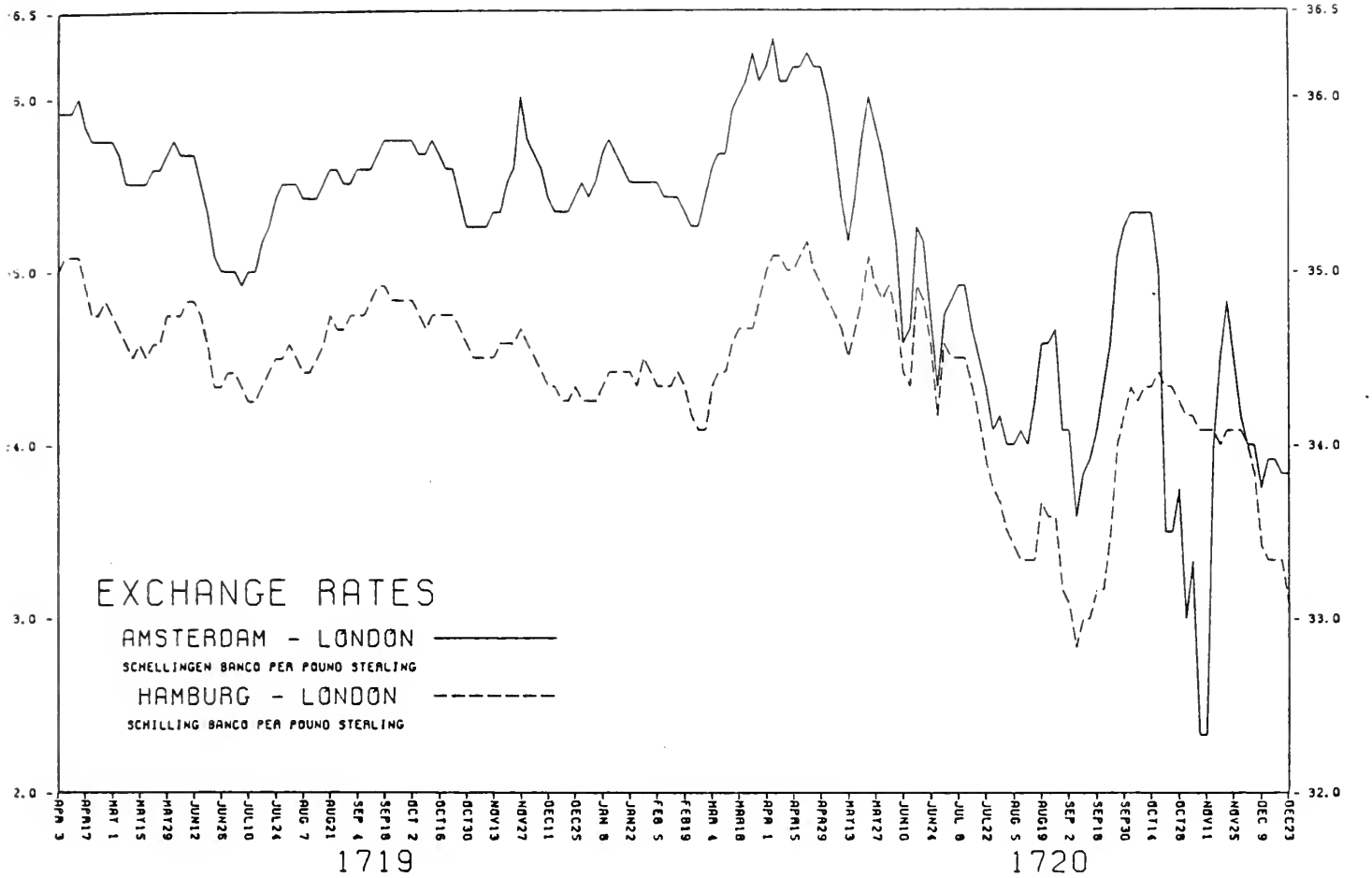


CHART 2.



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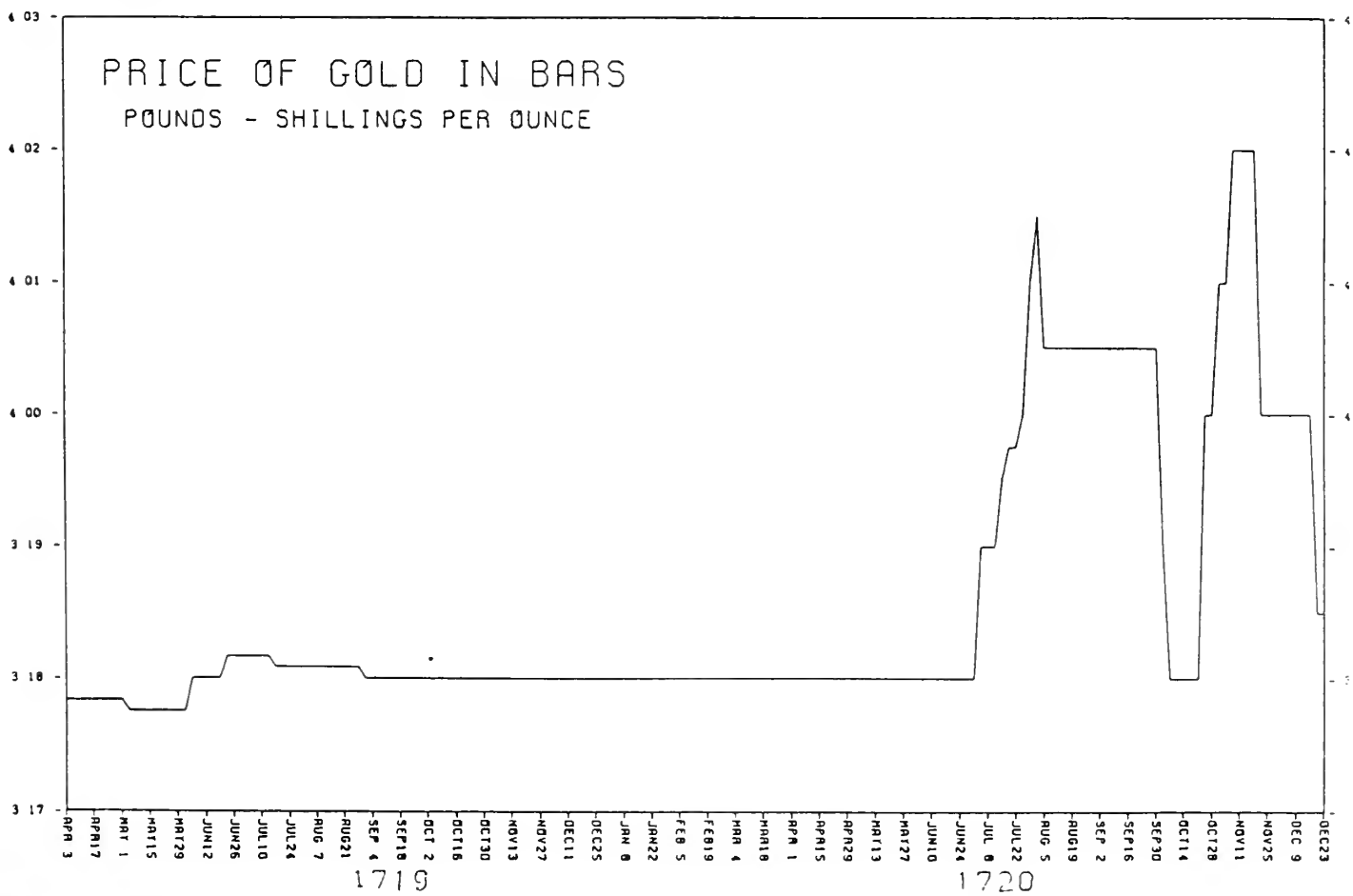

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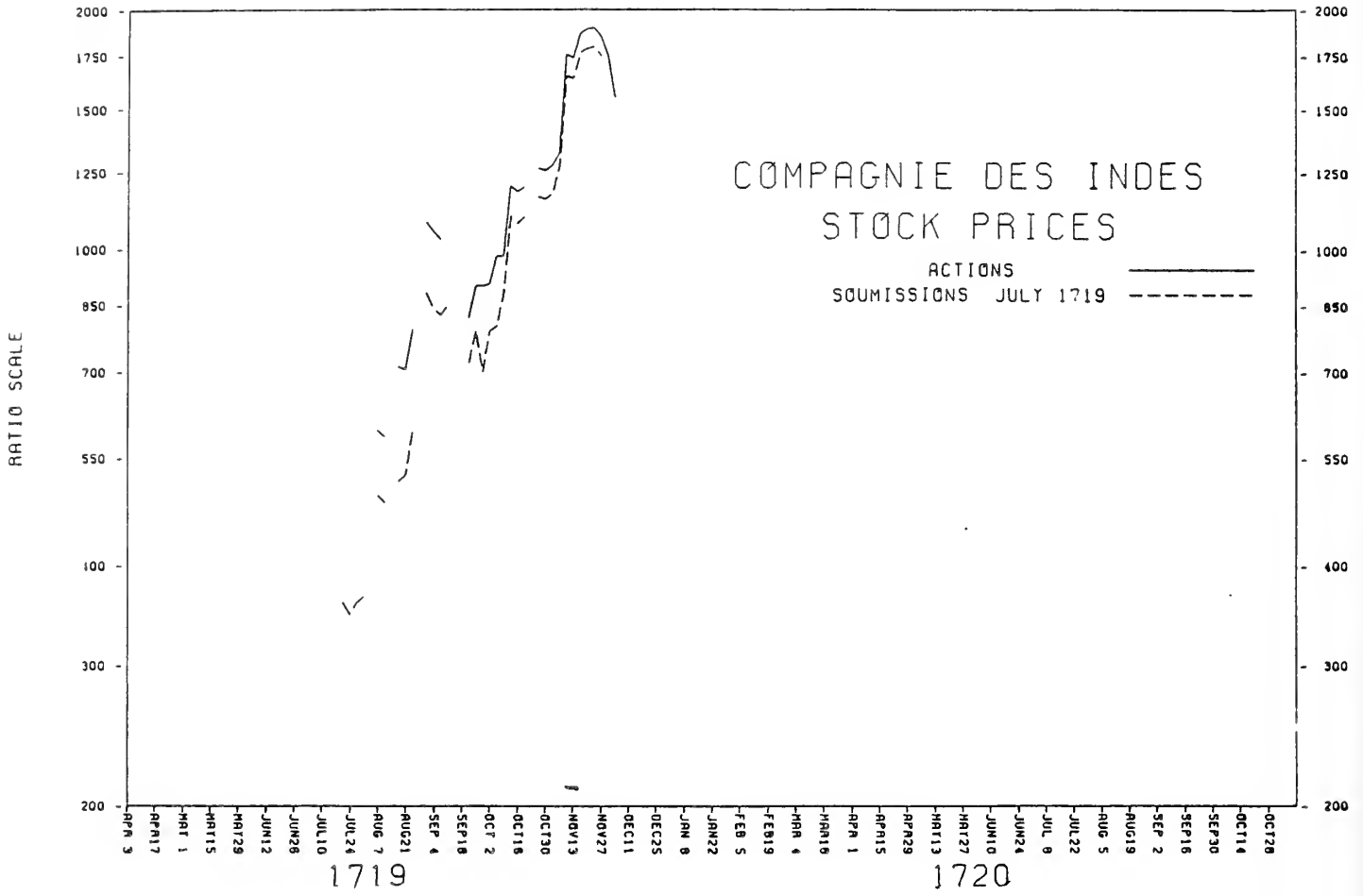

CHART 5.